DOCUMENT RESUME

ED 400 510 CS 012 620

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TITLE Errors Detection by 5- to 8-Year-Olds Listening to a Wrong French Sequence of Number Words: Music before Lyrics?
PUB DATE Aug 96
NOTE 9p.; Paper presented at the Biennial Meetings of the International Society for the Study of Behavioral Development (14th, Quebec City, Quebec, Canada, August 12-16, 1996).
PUB TYPE Speeches/Conference Papers (150) -- Reports - Research/Technical (143)

EDRS PRICE MF01/PC01 Plus Postage.
DESCRIPTORS Cues; Early Childhood Education; *Error Analysis (Language); Foreign Countries; French; *Language Acquisition; Language Research; *Language Skills; Listening Skills; *Syntax
IDENTIFIERS France (Montpellier)

ABSTRACT

Children, ages 5 to 8 years (n=71), were required to listen and detect errors out of a partly wrong sequence of tape-recorded French number words from 1 to 100. Children (from several schools near Montpellier, France) were from preschool, grade 1, and grade 2. Results show that wrong syntactic rules were better detected than omissions, whereas lexicalization errors were seldom detected at all. On the whole, the level of children's expertise being taken into account, findings suggest that children's performances are not entirely linked with the rule-awareness of number-words formation, and that the main cue for children to decide whether right or wrong is rather phonetic regularity. If so, this could bring some arguments to the "specific-integrated" versus "abstract-modular" debate. (Contains 11 references and 4 tables of data.) (Author/RS)

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ED 400 510

ERRORS DETECTION BY 5- TO 8- YEARS-OLDS LISTENING TO A WRONG FRENCH SEQUENCE OF NUMBER WORDS: *MUSIC BEFORE LYRICS?*

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SUMMARY

Children (ages: 5 to 8 years) was required to listen and detect errors out of a partly wrong sequence of tape-recorded number-words from 1 to 100. Results show that wrong syntactic rules are better detected than omissions, whereas lexicalization errors are seldom detected at all. On the whole, the level of children's expertise being taken into account, it seems first, that children's performances are not entirely linked with the rule-awareness of number-words formation, and then, that the main cue for children to decide wether right or wrong would rather be phonetic regularity. If so, this could bring some arguments to the "specific-integrated" *versus* "abstract-modular" debate.

INTRODUCTION

The acquisition of the number-words sequence leads to many theoretical questions. From a developmental point of view, we have now a better understanding of the process by which children learn the sequence (Fuson 1988, Fayol 1990), but these analysis concern mainly the beginning of learning. From a cognitive or general perspective, an important discussion contrasts the "abstract-modular" with the "specific-integrated" representation (Clark & Campbell 1991): is there an abstract or symbolic code, common to the different modalities of input (McCloskey & Caramazza 1987) or, on the contrary, does the representation consists of modality-specific codes interconnected in a complex network (Campbell & Clark 1988)?

Note that developmental analysis could benefit from cognitive propositions. Probably, the sequence of number-words is not "learnt" by the same mechanism at the beginning and after. Three basic and successive processes may be involved for a complete and stable acquisition: *word by word* learning for the beginning, *rules application* for the following, *rules awareness* afterwards (in fact, nobody "learns" 65.536 as a specific number-word...). On the other hand, since number representation is a quite long developmental construction, developmental results may be useful in the frame of cognitive debates like the above one.

The classic error-detection procedure is *a priori* a good way to get some enlightenments both on the level of "rule awareness" in children's number-words representations and on the input characteristics which determine judgments of (in)correctness.

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This procedure was already used by Gelman & Meck (1983, 1986) but for the first number-words, with young children, in the specific purpose to study the stable-order principle.

In our study, we extend the procedure to the 1-100 sequence. In French, the number-words system is not regular before *twenty* nor after 69. So, we had the opportunity to observe the detection (and correction) of many types of errors. Among them, we chose: omission/duplication, surextension (ex: "*dix-un*" instead of "*onze*"), wrong syntactic rule (ex: "*quarante-onze*" instead of "*cinquante et un*"), lexicalization (ex: "*septante*" - not used in France - instead of "*soixante-dix*"). Note that, except omission/duplication, errors are in a sense plausible because the lexical or syntactic transformations are right in other parts of the sequence. Then, the wrong words sound quite well...

Moreover, this study may be considered in the frame of comparative analysis which use the specificity of linguistic systems for general purposes. Further, it is well known that language characteristics act upon the sequence acquisition and cognitive representation of numbers (Muira, Kim, Chang & Okamoto 1988, Fuson & Kwon 1991, Baroody 1991).

METHOD

Subjects: The participants were 71 girls and boys (mean age 6;10 /SD: 10 months) from three school levels: preschool (n = 17 /mean age: 5;10 /SD: 3,5 months), grade 1 (n = 40 /mean age: 6;10 /SD: 4,9 months), grade 2 (n = 14 /mean age: 8;0 /SD: 10 months). Children came from several schools of a little town near Montpellier and villages around.

Procedure: Each child was interviewed individually according to the same global following procedure:

- *Counting-enumeration:*

We ask the child up to what number s/he can count. Then the child has to "count" (without reference) up to the greatest number s/he knows.

- *Errors detection:*

Children had to listen to a partly wrong number list (from 1 to 100), tape-recorded by a child speaking at the regular pace of one item per second. Each subject was told to knock on the table when s/he heard "a mistake" and then to try to indicate the right number-word instead. Indeed, children thought it was a very pleasant teacher-*rôle* situation...

- *On-line questions: "after 25, 29 and 35"*

When the list comes to 25 (and after 29 and 35), we stop the tape and ask the child if s/he knows what is to be said just after.

Two wrong number lists were recorded (list A and list B). To each child was submitted only one. These two lists were constructed in order to get the possibility of two different errors for the same number. Moreover, list A has a duplication (with different number-words) between 50 and 59. But many errors are the same for the two lists.

See *table 1* for the two lists and the localization of error types. The middle column indicates the right formulation.

Note that lists A and B were used for quite half children in each school level. The mean age was 6;10 (SD: 11,5 months) for list A and 6;11 for list B (SD: 9,3). Moreover, children from the two lists had similar performances in the counting-enumeration situation.

Table 1: Types and localization of errors and questions for list A and list B
("" point out the differences betweeen list A and list B*
"ok" are the right parts of the lists)

Error code or questions	**List A**	Right words	**List B**
	ok	1 up to 4	ok
error a	*omission*	5: "cinq"	*omission*
	ok	6 up to 10	ok
*error b1	*omission*	11: "onze"	*10-1 "Dix-un"*
	ok	12, 13	ok
*error b2	*omission*	14: "Quatorze"	*10-4 "Dix-quatre"*
	ok	15,16,17	ok
error b3	*omission*	18: "Dix-huit"	*omission*
	ok	19 up to 25	ok
q 25	"after 25?"		"after 25?"
	ok	26 up to 29	ok
q 29	"after 29?"		"after 29?"
	ok	30 up to 35	ok
q 35	"after 35?"		"after 35?"
	ok	36 up to 39	ok
error *c1	ok	40: "Quarante"	*4-0 "Quatre-zéro"*
c1	*4-1: "Quatre et un"*	41: "Quarante et un"	*4-1: "Quatre et un"*
c1	*up to 4-4:*	up to 44:	*up to 4-4:*
c1	*"Quatre-quatre"*	"Quarante-quatre"	*"Quatre-quatre"*
	ok	45: "Quarante-cinq" up to 49: "Quarante-neuf"	ok
error c2	*40-10: "Quarante-*	50: "Cinquante" up to	*40-10: "Quarante-*
c2	*dix" up to*	54: "Cinquante-	*dix" up to*
c2	*40-14: "Quarante-*	quatre"	*40-14: "Quarante-*
c2	*quatorze"*		*quatorze"*
		55: "Cinquante-cinq"	
*c2	*40-15: "Quarante-*	up to	ok
c2	*quinze up to*	59: "Cinquante-neuf"	
c2	*40-19: "Quarante-*		
c2	*dix-neuf"*	-	
*error c3	*duplication* with the		-
c3	right sequence:		
c3	50 up to 59		

.../...

Table 1: ***Continued***

Error code or questions	**List A**	Right words	**List B**
	ok	60: "Soixante" up to 69	ok
*error d1	*70: "Septante"*	70: "Soixante-dix"	ok
d1 d1 d1 d1	*71: "Septante-et-un" up to: 74: "Septante-quatre"*	71: "Soixante-et-onze" up to 74:"Soixante-quatorze"	*70-1: "Soixante-dix-et-un" up to 70-4 : "Soixante-dix-et-quatre"*
	ok	75: "Soixante-quinze" up to 79: "Soixante-dix-neuf"	ok
error d2 d2 d2 d2	*60-20: "Soixante-vingt" up to 60-25: "Soixante-vingt-cinq"*	80: "Quatre-vingts" up to 85: "Quatre-vingt-cinq"	*60-20: "Soixante-vingt" up to 60-25: "Soixante-vingt-cinq"*
	ok	86: "Quatre-vingt-six" up to 89: "Quatre-vingt-neuf"	ok
error d3 d3 d3 d3	*90: "Nonante" up to 94: "Nonante-quatre"*	90: "Quatre-vingt-dix" up to 94: "Quatre-vingt-quatorze"	*90: "Nonante" up to 94: "Nonante-quatre"*
	ok	95: "Quatre-vingt-quinze up to 100: "Cent"	ok

RESULTS

1) "Counting-enumeration" performance

For each child, we note the greatest number reached in a conventionnal utterance (i.e. without any mistake). These performances are classified in four levels, as it appears in *table 2* for the three classes. Of course, there is a link between school levels and counting levels.

Table 2: Subjects distribution for the "Counting-enumeration" performances crossed with the three school levels

"Counting" levels	**Preschool**	**Grade 1**	**Grade 2**	*TOTAL*
I: up to 29	12	5		*17*
II: up to 69	5	18	3	*26*
III: up to 99		5	3	*8*
IV: 100 and +		12	8	*20*
TOTAL	*17*	*40*	*14*	71

2) Errors detection and On-line questions

For every error, we code the response in three modalities: no detection / detection without correction / detection with exact correction. We note, too, the precise point of the list when the child knock on the table. For this short presentation, we indicate only (*table 3)*: the frequence of global detections, i.e. detections with corrections *plus* detections without corrections (in parentheses: frequence of detections *with* corrections), and the frequence of accurate answers for the "on-line" questions.

Results in table 3 may suggest many comments. Among these, we observe first a regular and important difference between detection and correction as if many children could point out that "something is wrong" but could not make out, in the situation, what is the right formulation. Second, correlations with counting-enumeration are not so obvious. Errors detections are clearly correlated with counting only in the case of *c2* and *d2* (for lists A and B) and in the case of *c1* and *d1* (for list B). We shall discuss these results. Third, some local differences can be emphasized. "14" omission (contrary to "11" or "18") is not detected frequently, but "10-4" is very shocking to children (as "10-1") and so better detected. "4-0" (very surprising too) is more detected than "4-1". Lexical transformation "*nonante*" looks more acceptable than the syntactic one "60-20"; the same for "*septante*" who seems to be less detected than "70-1".

Table 3: Percentages of error detections (and right responses to on-line questions) for the list A (n = 37) and the list B (n = 34)

(out of parentheses: % of detections with and without *corrections, within parentheses: % of detections* with *corrections.*
"": positive correlation (p<.05) with "counting-enumeration")*

Errors or Questions for list A	**List A**	**List B**	*Errors or Questions for list B*
a: "5" omission	.84 (.70)	.85 (.65)	*a: "5" omission*
b1: "11" omission	.73 (.35)	.76 (.50)	*b1: "10-1"*
b2: "14" omission	.38 (.19)	.82 (.50)	*b2: "10-4"*
b3: "18" omission	.78 (.59)	.79 (.65)	*b3: "18" omission*
q 25	.84	.88	q 25
q 29	.76	.65	q 29
q 30	.86	.82	q 30
c1: "4-1" etc.	.68 (.35)	.82 (.38)*	*c1: "4-0" etc.*
c2: "40-10" etc.	.84 (.49)*	.85 (.47)*	*c2: "40-10" etc.*
c3: duplication	.27 (.11)	-	-
d1: "septante" etc.	.73 (.24)	.82 (.38)*	*d1: "70-1" etc.*
d2: "60-20" etc.	.76 (.30)*	.79 (.24)*	*d2: "60-20" etc.*
d3: "Nonante" etc.	.38 (.11)	.41 (.18)	*d3: "Nonante" etc.*

3) False detections

Of course, children sometimes knock on the table even if the number-word is correct. But these "false detections" are not made at random. They appear mainly when the list come back to the right sequence. Indeed (*table 4)*, we count the number of false detections at 45, 50 (list A), 55 (list B), 75, 86, 95 (or just after these numbers, because of reaction delay). As we can see, false detections are quite frequent in these crucial parts of the lists, especially at "95" and also at "75" and "86" for list A.

Table 4: False detections (%) when the list comes back to the right sequence

Part of the sequence	**List A (n = 37)**	**List B (n = 34)**
FD 45	.16	.35
FD 50/55	.16	.24
FD 75	.57	.29
FD 86	.43	.18
FD 95	.73	.62

Moreover, if we sum, for each subject, the number of false detections in these five crucial periods and the number of other false detections, we obtain a mean of 1,9 for the former and 1,1 for the latter (which is the greatest part of the list). Furthermore, the correlation between the two types of false detection is too weak (.20) for calling upon a common underlying process.

Finally, we have some reasons to link each crucial false detection (45, 50/55, 75, 86, 95) with the just-before error-detection. For instance, among the 43 who did not detect the *d3* error, 32 (72%) did a false detection at "95". Reciprocally, there are very few false detections, of course, when children detect and correct the error just before.

DISCUSSION

Errors detection, all along the 1-100 sequence, seems to be a quite complex task, with several processes involved. It is not merely the consequence of expertise in counting, even if the task may inform on relevant cues for children.

Attentional processes take a part. Note what happens for "14" omission. This error is scarcely detected. Moreover, this detection is *negatively* correlated ($p<.05$) with counting-enumeration (this is the only significative negative correlation with counting). Probably, expert children are not enough attentive to catch this omission, but not for "5" or "11" (too evident) and "18" (which is in a local regular set).

Nevertheless, expertise in counting is correlated with some detections. Error *c1* excepted (where the wrong word is not so different from the right one both phoneticaly and syntacticaly), these detections - correlated with counting - are those which are both syntactic *and* in the second part of the sequence. So, the correlation is not surprising. But lexical transformations are not anymore detected by counting experts, perhaps because of their phonetic coherence with the set of preceding conventional rules (and though they are not here conventional)... and because they sound quite well.

Eventually, phonetic regularities are of main importance, possibly more important than lexical rightness, at least for the end of the sequence (see what happens to "nonante"!). So, it is likely that children are not aware of some true syntactic rules, even if they use the words (ex: "quatre-vingts" as four times twenty). Furthermore, that is the reason why false detections appear, above all, when the sequence comes back to the right words: the phonetic discrepancy is then too strong. But these false detections are not of the same nature when we consider children's comments (not analysed here). We have some reasons to differenciate three types of justifications for knocking on the table at these crucial periods: 1) wrong judgment *per se* (i.e. the right sequence is really considered as wrong); 2) wrong because it doesn't fit well with the previous words (ex: from "70-4" to "75": *"He adds 11 at one go!"*, said a child), so for some children in this category the number-words are simply impossible at this time but not wrong *per se*; 3) return to the right sequence as inducing the detection of the previous wrong words (these last were not counted as false detections, in our results, but it points to the importance of phonetic cues).

Phonetics cues are not surprising in oral modality, but if phonetic is more important than lexic, it means that oral modality must not be considered as a whole. In McCloskey's model, classic modalities (Deloche & Seron 1987) lead to a single cognitive representation. But in error detections, children seem to react to several cues, specially phonetic regularity. So, a simple mapping between specific words (whatever modality) and representation is not sufficient. It would be better to consider, in a quasi-network perspective, what sort of decision is speeded up by input characteristics and what sort of knowledge (specially rule awareness and operatory level) may control children's judgments.

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RESUME

On a présenté à des enfants âgés de 5 à 8 ans une séquence de mots-nombre (de 1 à 100) enregistrée au magnétophone et comportant des erreurs de différents types. Les enfants devaient arrêter l'enregistrement dès qu'ils détectaient une erreur, et la corriger si possible. Les résultats indiquent que les fausses règles syntaxiques sont mieux détectées que les omissions alors que les erreurs de lexicalisation sont rarement détectées. En tenant compte du niveau d'expertise des enfants, il semble que les performances à la détection d'erreur ne soient pas systématiquement liées à la connaissance des règles de formation des mots-nombre. En effet, le critère de décision principal pour les enfants paraît bien être la régularité phonétique. Ces données apportent quelques éléments au débat sur les modalités de représentation ("spécific-integrated" *vs* "abstract-modular").